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ABSTRACT

This paper presents a research project that investigates the values and uses of biodiversity. It was jointly investigated by the Wageningen Agricultural University and the University of Utrecht. The study engages a research-based stepping stone procedure for curriculum developers and educators in the (re)designing of teaching and learning in both formal and non-formal education. As a part of environmental education, sustainability education helps in critical decision making. The evolution from nature conservation education to environmental education to education for sustainable development can be characterized by the increasing awareness of the need for self-determination, democratic processes, and linkages between environmental and social equity. This research investigates the multilevel question, "What are the basic criteria, guidelines, principles, and constraints when developing the theme of biodiversity from an environmental education perspective?" Four main research tools have been used that include expert consultations, literature review, Delphi-study, and action research. (Contains 30 references.) (YDS)

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Education for sustainability, biodiversity, ill-definedness and respect for pluralism[1]

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Introduction

In a research project financed by the Dutch Ministry of Agriculture, Nature Management and Fisheries, the Wageningen Agricultural University and the University of Utrecht jointly investigated the various meanings, values and uses of biodiversity in order to tap its educational potential more fully (van Weelie & Wals, 1998; Wals, 1999). Based on interviews with various experts, a literature review and a Delphi-study, a stepping stone procedure was constructed for developing the theme of biodiversity within environmental education programs. Despite all the confusion about biodiversity, one thing is clear: there is no one single perspective or definition of biodiversity that accurately describes it in all situations or contexts. Biodiversity can have different meanings depending on the user and the context in which it is used (see for instance, Takacs, 1996; van der Maarel, 1997). Even within the scientific arena a great number of biodiversity meanings and interpretations can be distinguished (examples can be found in; Huston, 1994; Rozenzweig, 1995; Watson et al., 1995). It is not uncommon to find that scientific, political and symbolic meanings are used interchangeably by the same person. Both the knowledge base and the value base of biodiversity are variable and to a degree unstable and questionable.

Although these characteristics of biodiversity can render the concept useless or reduce it to a rhetorical instrument, they can also add to its strength when handled with care. Certainly from an environmental education perspective, but also from a policy-making perspective, these characteristics offer some worthwhile advantages: 1) Biodiversity renews discourse on nature

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conservation issues by a.o. bringing together different groups in society that are searching for a common language to discuss nature conservation issues in relation to sustainability issues. 2) This dialogue allows the socio-scientific dispute character of "science-in-the-making" to surface (Bingle & Gaskle, 1994). Participation in such a dispute is an excellent opportunity to learn about a highly relevant, controversial, emotionally charged and debatable topic at the crossroads of science, technology and society (Bybee, 1991; Fensham, 1988; Latour & Woolgar, 1979). 3) Making such a concept meaningful to the lives of citizens requires a procedure that could be utilized when developing educational programs that focus on similar topics (i.e. education for sustainable development).

In this paper a research-based stepping stone procedure for curriculum developers and educators engaged in the (re)designing of teaching and learning in both formal and non-formal education is proposed. One that recognizes the socio-scientific dispute character of biodiversity and provides a tool for turning biodiversity into a meaningful and existentially relevant issue. The procedure includes the following steps: analyzing meanings of biodiversity, determining one or more perspectives based on general learning goals of environmental education, setting specific learning objectives, selecting (sub)themes for learning and establishing a value of biodiversity. The procedure is an intermediate product that offers direction in developing and implementing specific learning activities and materials for various groups of learners. It is 'intermediate' in that the procedure does not provide for concrete learning activities – although it contains elements which might suggest steps in the learning process - but only is intended as a point of reference and reflection in the interactive development of environmental education activities. Currently the procedure is used for such interactive development in two different contexts: upper secondary Biology education and non-formal adult education.

Education for sustainability and ill-definedness

Education for sustainability, as derivative of environmental education, can be regarded as a social instrument in environmental policy-making which helps citizens determine their own pathways to sustainable living based on well-informed and critical decision making. At the same time it seeks to simultaneously provide them with the skills and action competence needed to act on those critical choices. The evolution from nature conservation education to environmental education to education for sustainable development is one that can be characterized by an increasing awareness of the need for self-determination, democratic processes, a sense of ownership and empowerment, and, finally, of the intricate linkages between environmental and social equity (see also Jensen & Schnack, 1994; 1997). As a result the educational component of education for sustainability, has become at least as important as the environmental

component (see also Corcoran & Sievers, 1994; Gough, 1997) . This shift in emphasis manifests itself in a heightened awareness, at least among some environmental educators, of the dangers mixing propaganda, persuasion and inculcation with education (see also Jickling, 1997; Wals & Jickling, *in press*). This heightened awareness also sensitizes many educators to the ill-defined nature of key emerging concepts such as biodiversity, but also sustainability itself.

As there is no one single way of looking at these issues or defining them we are dealing with so-called "ill-defined" concepts. Such concepts cannot be captured by single or universally applicable definitions, can be interpreted in many ways and are hard to operationalize in a specific application domain (van Weelie & Wals, 1999). Although this "ill-definedness" renders such concepts useless or reduces them to a rhetorical instrument from a 'modernist' point of view, it makes them attractive from a more 'postmodernist' perspective. We believe that environmental educators will find merit in the ill-defined nature of these emerging concepts when acknowledging:

- the need to respect pluralism (respecting different ways of looking, valuing, understanding, etc.),
- the ever presence of elements of ambivalence and uncertainty in environmental decision-making,
- and the need for learning situated in a rich context,

Using biodiversity as an example we will illustrate the educational appeal of ill-definedness and provide a heuristic for making a concept such as biodiversity meaningful in specific educational contexts. The heuristic is based on a four year study carried out in the Netherlands with support of the Dutch Ministry of Agriculture and Fisheries and the Dutch Interdepartmental Steering Committee on Environmental Education. Before describing the heuristic and its various components, we will outline the research.

Researching the educational potential of biodiversity

The general research question, originally posed to us by the Dutch government, was as follows: *What are basic criteria, guidelines, principles and constraints when developing the theme of biodiversity from an environmental education perspective?* The answers to this question were to be found within certain parameters known prior to the commencement of the research. To explore biodiversity within the framework of environmental education, attention had to be given to the development of the following learning domains: knowledge-insight, involvement-values, responsibility-morality and, finally, skills-action competence. Furthermore, an analysis of the educational potential of biodiversity from the perspective of each of these learning domains

would have to be complemented with an analysis of appropriate learning and instruction processes. The essential criteria, guidelines and principles for developing the theme of biodiversity within environmental education were to be synthesized in a foundation and procedure for curriculum development. This foundation and procedure had to be grounded in environmental education and biodiversity literature, in the opinions of experts, and the opinions of practitioners active in (environmental) education or policy-making. Only then would the foundation and procedure be general enough to be adapted to a wide variety of contexts, yet concrete enough to provide practitioners with sufficient imagery for the design of specific learning activities.

In trying to answer the different parts of this question, we made use of four main research tools which would fit the parameters outlined above: expert consultations, literature review and Delphi-study (i.e. Linstone and Turoff 1975; Mayer 1995; 1996) and action research (Table 1).

Overview of the research	
Goal: to generate essential criteria, guidelines, principles and constraints for developing the theme of biodiversity within environmental education programs	
Method	**Purpose**
Expert-consultations (n=9)	*General Orientation* (meanings, values, ethics, philosophy, psychology, policy, environmental education)
Literature review	*In-depth Study* (meanings, values, ethics, psychology, instruction, environmental education)
Delphi-study (n=32)	*Stepping stones for contextualizing biodiversity* (learning enhancement criteria, objectives, guidelines, perspectives and themes)
Action-research (two cases)	*Development of educational materials* (working interactively with the stepping stones in both non-formal education and in formal secondary education)

Table 1. Composition of the study

1) Expert consultations. In order to generate starting points for a selective reading of the extensive biodiversity literature, a series of nine expert interviews was conducted as a first step in the research process (Table 2). The interviews were conducted with experts from a variety of relevant fields (Pedagogy, Biology, Environmental Education, Environmental Policy, Philosophy of Social Science and Philosophy of Biology) to get as many perspectives as possible early on in the research. The interviews were audio-recorded and transcribed for content analysis.

AREA OF EXPERTISE	EXPERTS								
	1	2	3	4	5	6	7	8	9
Pedagogy	X	X	X				X		
Biology				X	X	X			X
Environmental Education	X	X	X						X
Environmental Policy			X						
Philosophy of Social Sciences	X						X	X	
Philosophy of Biology					X	X		X	

Table 2. Expertise consulted in expert interviews

2) *Literature review*. We made use of some standard works on biodiversity as a scientific and political concept. Furthermore we included some international policy documents on biological conservation, a review of recent trends in environmental education and some research articles that dealt specifically with biodiversity and environmental education. Our selection was in part based on the expert consultations held earlier.

3) *Delphi-study*. Biodiversity is a new theme for environmental education. Just as its meaning, value and use were very much in question at the on-set of the research, so was its educational potential from an environmental education perspective. Although it appears that there is consensus at the (inter)national policy level about the meaning and importance of biodiversity, it appears that such consensus is lacking in both the scientific and the environmental education community. If the result of this research - a foundation and procedure for curriculum development - is to be of any use then it is crucial that it be grounded in the experience, ideas, desires and concerns of the various user groups, and that some kind of agreement is reached as to what learning about biodiversity entails. The complexity of the theme and the wide array of possible educational operationalisations made it difficult to satisfactorily identify workable issues, specific needs and individual points of view, and to involve people in the decision making process. Therefore our attention was drawn to the Delphi-method.

The Delphi process is designed to tackle complex issues by first eliciting opinions or judgements from all respondents, then summarizing the various opinions, confronting each respondent with alternative points of view and providing them with an opportunity to revise their original perspective in light of new information. The Delphi process is basically a program of sequential questioning interspersed with information and opinion feedback (Linstone & Turoff, 1975; Mayer 1992). The questioning is usually conducted in several rounds using a survey format and carefully selected representatives of groups that are, in one way or another, involved in the

issue at stake. Table 3 shows the Delphi-process designed for the research on environmental education and biodiversity.

In this study the Delphi-approach was designed to find answers to two sub-questions that follow from the general research question. The first sub-question (round 1) focused on the content of biodiversity education from an environmental education perspective: To what extent do the participants underwrite the conclusions drawn from the preliminary expert interviews and literature review with regards to the contents of biodiversity education, and what ideas or content elements do they find missing? The second sub-question (round 2) was intended to validate the results from round 1: To what extent do participants identify with the conclusions drawn from round 1 of the Delphi, and what ideas or content elements do they still find missing? In round 2 of the Delphi the participants were exposed to the ideas offered by other participants in round 1. The participants spent on average 90 minutes on round 1 of the Delphi and 45 minutes on round 2. This suggests that about 80 hours of focussed thought went into the Delphi. This input is reflected by the elaborate answers that were given to the more open-ended questions and by the vast amount of commentary provided in the comment section of the more closed questions.

Overview of the Delphi-study	
Goal: mapping contents, contexts and goals for learning about biodiversity from an environmental education-perspective, and generating support	
Element	**Objective**
Round 1 Questionnaire	- encouraging creative and critical thought among the participants in order to generate contents, contexts, goals and criteria for learning about biodiversity - analyzing and summarizing the main arguments put forward by participants for feedback in round 2
Round 2 Questionnaire	- anonymous feedback of selected contents, contexts, goals and criteria and corresponding arguments to all participants - drawing the attention of participants to possibly new issues or sub-questions that emerged from round one which seem of particular interest

Table 3. Design and objective of the Delphi "Environmental education and Biodiversity"

The participants represented a variety of interests and/or user groups: environmental policy-makers, environmental education resource persons, upper secondary school teachers, curriculum developers, NGO-workers and members of youth organizations involved with environmental issues (Table 4). To assure that as many perspectives as possible emerged from

the study, a category of people was added which included philosophers, artists and writers. For each category a minimum of five participants were nominated by a key informant who is well known within a specific category.

Category	n-participants in round 1	n-participants in round 2
Public service workers (employees of a zoo and a museum)	4	4
Environmental educators (employees of a visitor centre and an environmental education-centre)	5	5
Youth representatives (employees of a youth organisation)	7	6
Secondary school teachers (specialised in geography, biology or economics)	6	5
Curriculum developers	3	3
Policy-makers (at the national level)	3	2
Miscellaneous (artists, writers, philosophers)	4	2
Total	32	27

Table 4. Number of Delphi-participants (n) in rounds 1 and 2

When looking back at the use of the Delphi-method as one of the research instruments used, we conclude that its explorative value has been reconfirmed here. The answers to the questionnaires have provided a wealth of information that contributed significantly to the stepping stone procedure and all its elements. At the same time, we must recognize that the wide range and impressive number of, sometimes, disparate ideas that were elicited, overwhelmed the researchers more than once. This vast amount of diverging ideas and information is partly the result of the way the questions were posed and partly the result of the ingenuity and creativity of the participants (who were selected on their ability to contribute meaningfully and extensively to the research from a variety of angles). It was not always easy to utilize all the information provided. Due to time constraints it was not possible to introduce a third round to converge more towards greater coherency and consensus.

4) Action research. Steps one through three in the research process resulted in the heuristic or stepping stone procedure that is presented in this paper. The stepping stone procedure already is a kind of synthesis between insights from theory (step 1 and 2) and practice (step 3), but working with the procedure to develop and evaluate meaningful learning activities had to be done through a more interactive and participatory process which also allowed the perspective of the learner to enter more prominently. The interactive method used in this phase of the research was based on an action research approach such as described by Carr and Kemmis (1986) and McKernan (1991), and used by Wals and Alblas (1997). Central to this method is creating

synergy between theoretical notions and practical experience through joint action and reflection by academic researchers and practitioners (i.e. teachers or educational consultants researching their own practice).

Five central features can be distinguished (Wals & Alblas, 1997):

- the collaboration and interdependency between academic and practitioner researchers;
- the problem solving nature of the inquiry process of all participants;
- the spiral development of the inquiry process and its reflective nature;
- the development of so-called grounded theories rooted in both theory and practice (Glaser & Strauss, 1967; Strauss & Corbin, 1990; 1994);
- the dialectical nature of inquiry.

The main objective of this research phase was to design concrete learning activities that tap the educational potential of biodiversity to the fullest from an environmental education perspective. The insights obtained from phase one through three were to be used, non prescriptively, as a point of reference and reflection. Two contexts for the action research phase were identified at the start of the research: upper secondary education (formal education) and community based adult education (non-formal education). Since the results of both cases were not yet available at the time of the writing of the paper, we will only report on some preliminary findings in the discussion section.

The findings that emerge from this type of research are only transferable to other settings when the act of generalizing is viewed as a process of dialectic interacting between the reader and the author. This process requires the reader to relate the findings of a study to his or her own experiences. At the same time it requires the author to present the findings as subject to interpretation, adaptation and rejection. This approach differs from the "what research says" approach which tends to be more prescriptive. What one learns about one teacher's or a small group of teachers' thinking about integrating the topic of biodiversity into regular teaching, for instance, can raise one's consciousness of features that *might* be found among other teachers (Eisner, 1991). Studies of this kind are unable to claim that all teachers will share identical or even similar ideas and preferences but rather that these are features one might look for among other teachers (Eisner, 1991; Morse, 1994).

Making biodiversity meaningful: some stepping stones

We will briefly outline and describe several stepping stones that can be used to contextualize biodiversity for education purposes. With contextualizing we mean anchoring a biodiversity

concept meaningfully in the thoughts and actions of people in a specific context. These stepping stones (Table 5) should be seen as a starting point for interactive curriculum development. By following these steps and applying the knowledge and experiences of environmental education practitioners, curriculum developers can responsibly and meaningfully integrate the topic of biodiversity in environmental education programs, for instance, through a process of action research (Wals & Alblas, 1997). The steps, which do not necessarily have to be followed in a particular order, are described in more detail in van Weelie & Wals (1999).

- *Analyzing meanings* of biodiversity as used in policy documents, scientific literature and the media by comparing them to the general working definition.
- *Determining perspective(s)* based on general learning goals of environmental education.
- *Setting concrete learning objectives* that are compatible with the general learning goals, the four distinguished foundations and the selected (sub)themes.
- *Selecting specific (sub)themes* that complement the perspective(s) chosen.
- *Establishing the value of biodiversity* through a process of clarifying, analyzing, selecting, acting and evaluating.

Table 5 Stepping stones for contextualizing biodiversity through environmental education

Analyzing meanings

A challenge for environmental educators is to enable the learning to attach personal meaning to biodiversity by embedding it in a very specific context in which the learner is or becomes psychologically and physically involved. In order to do so we have to use a simple working definition that captures the core elements that make up biodiversity:

Biodiversity represents variability (v) in biological entities (b) and their inter-relatedness (l) in a specific space (s) at a specific moment in time (t).

If biodiversity is to become a meaningful concept with an empirical reference, four questions will thus have to be answered:

- *What biological entities are at center stage here?* Many different biological entities have been the subject of biodiversity studies, policies and debates. The most common entities used by conservation groups are species and ecosystems, followed by genes, but there are many others (i.e. functional units or guilds, habitats, homogenous plots, etc.).
- *What kind of variability are we talking about?* Variability is a statistical term that can be used in two different ways: variability as *richness* and variability as *relative abundance*. The former refers to the number of biological entities in a certain location at a certain time. The

latter refers to the number of individuals belonging to a specific biological entity in a certain location at a certain time.

- *How are these entities related to each other?* Biological entities are part of webs of interdependencies. The disappearance of one species, for instance, may affect the presence of another.
- *To what geographical location do we limit ourselves?* Whenever we speak of biodiversity we need to specify in what area this biodiversity can be found or what area we would like to include in, for instance, our monitoring activities.
- *What point in time or time interval will we focus on?* The time factor adds another dimension to biodiversity. Not the distribution of biological entities in space, but the dynamics of these entities over time becomes important here. When we speak of biodiversity loss, for instance, we need to consider both what is actually being lost, where and over what period of time (at what rate).

These questions can be used to make critical analyses of the various uses of biodiversity and to develop a clear focus and sense of direction for an environmental education activity. The more pointed the answers to all four questions, the more focused and fruitful discussions will become on the facts and values related to biodiversity. Using the four questions, learners are able to generate a contextual definition of biodiversity that is immediately relevant to their own interests and concerns. It is clear that to contextualize biodiversity and defuse its ill-defined meaning, all four variables in the definition will need to be specified at some point during the educational process.

Determining perspectives

From the wide number of ideas put forward by the participants in the Delphi-study, three main perspectives on education about biodiversity could be distilled (Table 6). The perspectives are basically correspond with three general goals of environmental education: ecological literacy, personal growth and development, and an understanding of the socio-scientific dispute character of environmental issues. Within each perspective one of these general goals dominates.

The three perspectives are intended to help curriculum developers navigate through the wide array of possible learning goals and perspectives one could emphasize when focusing on biodiversity. They can help them specify specific learning goals and objectives for education about biodiversity. The perspectives can be useful when analyzing existing teaching materials on biodiversity. They have analytical value in that they help clarify and distinguish learning

goals, learning activities, learning contexts and associated meanings of biodiversity. It should be stressed that the language used in the table is the language used by the participants in the Delphi-study, and not the language of the academic researchers. Although some interpretation is inevitable.

A) Ecological literacy To start with, develop ecological literacy by addressing the intricate relationships that exist between different species that share ecosystems. Proceed by discussing the position of humans within an ecosystem and their impact on it. The learner has to understand the ecological consequences of human behavior. At the same time, the learner has to see possibilities for averting ecological damage by, among other things, wise use of technology. Key ideas to be included are: species, habitat, ecosystems, relationships between species, food webs, nature, human impact, etc.
B) Nature and self Start by creating opportunities to experience and value nature first-hand. Go outside. A new or renewed relationship with nature could encourage the learner to participate more actively in nature conservation programs. Any knowledge and understanding needed to experience nature and to participate in conservation programs can be obtained experientially as the need arises. First and foremost, the learner has to come to love nature and to appreciate its diversity. Special attention will have to be given to active caring for other living things (including fellow human beings). Key ideas to be included are: enjoyment, sense of wonder, appreciation, experience, landscapes, conservation, caring, etc.
C) The politics of nature Start by raising the issue of a more equitable distribution of natural resources. Highlight and explain important international treaties and conventions. The learner has to understand the way the (international) political arena works, what treaties are and what their impact (or lack thereof) may be. At the same time, the learner has to understand the responsibilities of individual citizens in contributing to: local decision making, the democratic process that precedes international treaties, the implementation of such treaties (concrete action at the local level) and the role and position of scientists and scientific knowledge in public decision making. Key ideas to be included are: sustainable development, use of natural resources, North-South relationships, respect, genetic manipulation, exploitation, responsibility, democratic decision making, ecological agriculture, etc.

Table 6. Three educational perspectives of biodiversity as distilled from the Delphi-study

Establishing learning goals

Contextualizing the concept of biodiversity does not in and of itself guarantee that it will become a suitable topic for environmental education. When developing an environmental education program we also have to relate an analysis of the meaning of biodiversity (see the working definition) and the determination of an educational perspective (Table 6) to appropriate learning goals. Four arguments or justifications for learning about biodiversity surfaced in the study: the emotional argument, the ecological argument, the ethical argument and the political argument (Table 7). Although there will be differences in emphasis, depending on the learner, educator, educational setting or available means, all four arguments have to be addressed somehow if education about biodiversity is to be called environmental education.

- *Emotional argument*: (re)connecting with nature through discovery and sensitization, and experiencing biodiversity to create personal meaning.
- *Ecological argument*: understanding relationships, functions and (global) interdependencies.
- *Ethical argument*: dealing with values, taking a moral position, raising critical questions.
- *Political argument*: dealing with controversial issues, making choices, developing action competence.

Table 7 Environmental education foundations for learning about biodiversity (overlap is inevitable and desirable)

The three perspectives from Table 6 (ecological literacy, nature and self, and the politics of nature) and the four arguments listed in Table 7 can be used to establish learning goals and concrete learning objectives. These goals and objectives should link these perspectives of biodiversity to the specific contents, concepts and themes to be covered in the learning process. The perspectives and arguments show remarkable compatibility with generally accepted goals of environmental education, i.e. the establishment of:

- personal and emotional involvement with nature and the environment,
- personal and emotional involvement in the environment as an issue in society and the community,
- environmental literacy and skills,
- empowerment and action competence, and
- intrinsically motivated change in environmental behavior.

Table 8 shows how different perspectives on biodiversity from an environmental education vantage point can be linked to general environmental education learning goals.

Perspective	Primary learning goal	Secondary learning goal
A) Ecology and society	- Environmental literacy and skills *(ecological argument)*	- Involvement in society and community *(political argument)*
B) Nature and self	- Personal and emotional involvement in nature and environment *(emotional argument)*	- Reflection on role of humans and self in species extinction *(ethical argument)*
C) The politics of nature	- Involvement in society and community *(political argument)*	- Personal and emotional involvement in nature and environment *(emotional argument)*

Table 8 Linking perspectives on biodiversity to general environmental education learning goals

When developing concrete learning activities curriculum developers are now better postioned to link the perspectives to potential learning goals for biodiversity within the realm of environmental education.

Developing themes

In addition to choosing a specific perspective with which to approach the topic of biodiversity and deciding on the learning goals and objectives, it is useful to generate concrete themes. Such themes are needed to make the transition to specific contents, objectives and contexts for learning about biodiversity.

How can we select appropriate themes for learning about biodiversity? This depends on the point of departure of the teaching and learning development team. We already indicated that the stepping stones which make up the procedure for making biodiversity meaningful, do not have to be utilized in any particular order.

There are several possible points of departure:

- A specific explicit and predetermined (i.e. by those involved in the designing, teacing and learning process) meaning of biodiversity
- A specific explicit and predetermined perspective on biodiversity
- A specific explicit and predetermined learning goal
- Existing teaching materials and activities.

Below five exemplar themes are listed, which are compositions based on the many themes the participants in the Delphi-study nominated for this purpose. Again, the language used mimics the language used by the participants. The content of the boxes should be considered as suggestions for exploration and not as prescriptions for teaching and learning.

A. Backyard Biodiversity – People are surrounded by animals and plants - many more than you can imagine. The backyard, the school grounds, the balcony and living room all are testimony to this. But if you look closely, you will be surprised to notice so many species that you never encounter. In the soil, under a rock or a brick, processed in everyday tools, foods or materials, even in your own body! Using special observation techniques and instruments, like a magnifying glass or a microscope you can discover more and more forms of life. Take a set of binoculars and look into the branches above your head. Using field guides and reference books you can begin to name and classify the species you come across. This will provide you with a sense of biodiversity in your own local environment. This biodiversity will vary from place to place. Why is this? Investigate what factors influence biodiversity. Without all these different plant and animal species life would be boring, would it not?

- Focus is on the diversity of species in people's homes, schools, communities and backyards.
- Emphasis is on accurate observation, identifying, naming and monitoring.

B. Design a Habitat – Every animal needs other animals and plants to exist. An otter needs fish for food. Water plants are essential for clean water, which both the otter and the fish need.. Every animal is well adapted to its environment, but in urban areas the reverse is possible too: people adapt the environment to accommodate the animals. Small predators, such as the otter, would otherwise hardly exist anymore in a country like the Netherlands. Adaptation and habitat restoration and even artificial habitat creation, a must? Pick an animal you feel connected to or pick a special place on Earth. Design the perfect environment for your animal. A visit to the Zoo will enable you to compare your design with nature. You will find seemingly oddly adapted animals and will find an explanation of their natural habitat and co-habitants. Do you recognize some of your own solutions?

- Focus is on the conditions and requirements for species to thrive, survive or take a dive.
- Emphasis is on relationships, ecological principles, and factors influencing habitat loss and creation.

C. Biosphere, not Biosfear – The biosphere is the earth's ecosystem. Biodiversity is the diversity of life forms on Earth. All these different species complement each other and keep each other in balance. Life supports life. The biosphere consists of a number of smaller varying ecosystems – ecosystem diversity – such as; oceans and coral reefs, watersheds and rainforests. Such ecosystems are important because of the enormous amount of species diversity they contain. There are many possibilities for learning about this: books, videos, the Internet, Zoo's, etc. Large ecosystems of significance can also be found in a small country such as the Netherlands. Think of the North Sea or the Waddensea, for instance. These ecosystems are obviously closer to home than the tropical rainforest. Join a commercial fishing expedition and examine the catch. Or, study the plant diversity in the dunes. Do you see how an ecological balance is preserved? What threats and opportunities do you see?

- Focus is on the biosphere, its ecosystems, their relationships and their life support functions for species, including Homo sapiens.
- Emphasis on understanding global linkages and interdependencies and the notion of a dynamic equilibrium.

D. The Last Dodo...So What? – Everyday astonishing numbers of species disappear, most of which we have never seen or discovered. In our time more species go than come. In other words, there is a net loss of species diversity. Something to stop and think about... but is this really tragic? Maybe this is just a short period of decline in the Earth's long history during which diversity overall has increased tremendously. Before Homo Sapiens walked on this planet, countless species were both formed and became extinct. Think of the dinosaurs that became the victims of a natural disaster. What can we learn from this today? Not everything is our fault! Our behavior does impact species diversity negatively at times, but so does nature's behavior! Besides, do we really miss that dodo? Will our grandchildren miss the sable tooth tiger? Organize a forum discussion with guest speakers focusing on the question: 'Which species should we protect and which ones should we allow to become extinct?'

- Focus is on the extinction of species, most of which we have never even known. Questions are raised about the current net loss of species on a global scale. Is it really so bad?
- Emphasis is on values, the role of people in affecting the state of biodiversity and the relationship between people and nature.

E. Shaping Biodiversity – All people depend on the earth's biodiversity, even the yuppies with their microwave meals. In many sectors in Western society you can still experience this dependency first-hand. For instance in the agriculture, fisheries, tourism and recreation sectors. When talking to people working in these sectors you can learn a lot about biodiversity. Interview for example a forester, a farmer, a policy-maker or a fisherman and he or she will tell you about diversity and how it has changed over time. Select a sector that interests you. Human consumption often negatively impacts biodiversity, but you will see that people can also have a positive impact. How do you make room for biodiversity in an urban setting or in the countryside? Visit some success stories and draw up you own plans for making a positive contribution to biodiversity. Capture as many different perspectives as possible. What are facts and what are myths? What is sure and what is not?

- Focus is on our dependency on biodiversity and the way people shape biodiversity both positively and negatively.
- Emphasis is on values and uses of biodiversity, the impact of consumers and producers on biodiversity and the development of action competence to positively impact biodiversity.

Obviously, the above themes have been derived from people with differing vocations who responded to an extensive survey. When designing a specific learning situation or context, the selection of a theme will also be influenced by a number of conditions or factors including: the people to be reached, the kind of learning situation (i.e. school-based, community-based, formal, informal, etc.), overall learning goals one has to work within, the environment (and biodiversity) at stake, etc.. In every situation, a specific theme to focus seems essential to tie specific meanings, perspectives and goals together in a meaningful set of learning activities.

Valuing biodiversity

We can ask ourselves whether biodiversity has a particular value and, if it does, for whom? Intuitively one is inclined to think 'of course biodiversity is valuable' for 'life' is valuable and 'variation is better than more of the same.' At a very basic level this might be true, but as soon as we go beyond the symbolism and start digging for meaning and empirical references we enter a world of buzzing confusion and stubborn complexity. The global distribution and equity issues that surround biodiversity perhaps most easily demonstrate the socio-scientific dispute character of biodiversity, with its underlying political and normative claims. Most of the world's species, for instance, are found in tropical forests in the Southern hemisphere. The protection of the tropical rainforests is mostly promoted by politicians and scientists from the North. How can people from 'The North' expect people from 'The South' to preserve their forests after we have destroyed most of ours in an attempt to gain material wealth and to increase the quality of life? Much of the deforestation is even orchestrated by multinational companies from the North itself... This is just one way of reasoning, of course, but it does highlight the dispute character of biodiversity.

There are many more questions that can be asked about the use and value of biodiversity. Some will argue that its value is in its use and that the trick is to first demonstrate, in economic terms, the contribution biological resources make to the country's social and economic development. Others, recognizing a non-economic value of biodiversity as well, have come up with more comprehensive value categories for assessing the value of biological resources (see for instance Table 9).

DIRECT VALUES

Consumptive use value: **assessing the value of nature's products that are consumed directly, without passing through a market (firewood, fodder, and game meat).**

Productive use value: **assessing the value of products that are commercially harvested and sold in a market (timber, fish, ivory, medicinal plants).**

INDIRECT VALUES
Non-consumptive use value: contributing to ecosystem functions (watershed protection, photosynthesis, regulation of climate, and production of soil).
Option value: keeping options open for the future (a safety net of diversity).
Existence value: knowing that certain species exist.

Table 9 One attempt to establish the value of biodiversity (source: McNeely et al., 1990)

Ehrenfeld believes that discussions about the value of biodiversity serve only one end: delay of action, the continued exploitation of the world's resources and the betterment of a relatively small group of people (Ehrenfeld in McNeely et al., 1990). Wood suggests that humans are in a state of "obligatory dependency on biodiversity." Due to various reasons, biodiversity appears to "beget biodiversity," to be a necessary precondition for the self-augmenting maintenance of itself. Biodiversity is therefore a necessary precondition for biological resources, and it cannot be traded off. This appears to be its quintessential value. And the conclusion is relatively abstract: any "resource" may be traded off, by any society, to fulfil its socio-economic interests, or its survival needs, *provided that biodiversity is not depleted* (Wood, 1997).

The Delphi-participants generally supported the notion of establishing a political and ethical foundation for biodiversity and recognized the importance of sound decision making, critical thinking and the development of values. So far the proposed stepping stone procedure allows us to:

- move from general learning goals to specific learning objectives
- translate broad and fuzzy concepts of biodiversity into concrete themes which treat specific aspects of biodiversity
- transform the general meaning of biodiversity (as represented by the working definition) into a situated or contextualized meaning.

By contextualizing biodiversity it can become meaningful in a specific context. However, from an environmental education perspective, it is insufficient to expose learners to a wide array of such contextualized uses of the concept of biodiversity. Even though we now may be able to recognize specific forms of biodiversity within, for instance, our own environment, we have not yet addressed the normative aspects underlying this biodiversity. It is precisely this normative component which is interesting from an environmental education perspective, since it provides access to socio-scientific disputes.

The most important pedagogical aspect of entering into a socio-scientific dispute is the inherent possibility of making connections and distinctions between factual and normative claims. The discussions in a socio-scientific dispute can lead to a better understanding of the connections

between ecological and environmental issues and their significance for science, technology and society. The meanings of biodiversity that we are able to distinguish by applying the proposed procedure, up until now, are the meanings of different biodiversity concepts in varying contexts. These meanings and contexts can be specified further by asking questions that reveal its socio-scientific dispute character (Table 10).

1. What kind of biodiversity is referred to in this particular situation? 2. What facts are known about this biodiversity; what remains uncertain? 3. What values, claims and uses do the various interest groups attribute to this biodiversity? 4. What values, claims and uses do individuals personally attribute to this biodiversity?

Table 10. Questions to help a learner enter the socio-scientific biodiversity dispute

Answering the first question requires a contextual definition of biodiversity for which the proposed procedure seems adequate. Answering the second and third questions requires some research that could include the questioning of stakeholders. The fourth question should be returning throughout the learning process.

When entering a socio-scientific dispute - which in essence is the clashing of different contexts , i.e. the lack of agreement on goals, norms, values and the absence of a common language - the process of valuing enters the educational program. This is an enormously complex process that is hard to capture in a linear and prescriptive model. Delhaas and Koekoek (1994) have made an attempt to distinguish various steps in this complex process. Table 11 contains a somewhat simplified representation of these steps in the values clarification and development process. The steps can provide some landmarks or beacons to recognize, focus on and to intensify the process. It should be noted that the order in which these steps are followed and the emphasis given to them is not always the same; these depend very much on the person going through this process and the situation he or she is in.

When going through the various steps in Table 11 one can take different approaches depending on the learning goals one wishes to emphasize and the group of learners one wishes to reach. For instance, one could take a more emotional approach in which personal feelings and experiences with regards to biodiversity-related issues or elements take center stage. Or one could take a more rational approach in which the opinions of others on more factual, technical or scientific aspects of biodiversity take center stage. One could also take a more action-oriented approach in which the development of action competence and a perspective on possible actions or ways to act take center stage.

1. *Identifying*	- recognizing values - labeling your own values and those of others without judging them
2. *Analyzing*	- distinguishing the different components of values - recognizing the relationships between values - sorting and prioritizing values - tracking the source of values - studying the implications of values - exposing contradictions between values
3. *Choosing*	- weighing the consequences of different values - arguing the merits of alternatives - selecting and openly defending the selected alternative
4. *Acting*	- putting your values to work (translating them into actions) - reflecting on the experience
5. *Evaluating*	- determining the value of the selected alternative - determining the value of the perceived consequences of putting the new value into practice - assessing the level of consistency between valuing and acting
6. *Reconsidering*	- confirming the choices one has made and accepting their consequences or - reconsidering one's choices in view of one's reflections and evaluations

Table 11. Some steps in the values clarification and development process
(adapted from Delhaas and Koekoek, 1994, pp. 235-36)

The socio-scientific dispute, with its underlying normative claims, which characterizes biodiversity, provides a tremendous challenge for environmental educators. Learners are confronted with many such concepts in everyday life. In the domain of environmental education one can think of sustainable use, sustainability, sustainable development or even nature conservation. Recognizing the different political, symbolic and scientific uses of such concepts and making a critical assessment of their strengths and weaknesses, and of their knowledge and value claims, could be an important learning objective in environmental education. Exploring the different meanings, values and uses of biodiversity could easily become a vehicle for the development of critical thinking skills.

Discussion

The stepping stone procedure was the result of a first almost three years of the four year research project. The Delphi-phase of the research weighed heavily on the construction of the procedure. Although the Delphi did included a variety of groups preoccupied with environmental education and/or biodiversity, relatively little attention was paid to the perspective of the learner (although representatives from youth organizations were included in the Delphi). This was generally considered a weakness of the study which is why the fourth step in the research, the action research step, was to engage with the procedure during the interactive development of learning activities and materials.

As mentioned earlier, the stepping stone procedure was used as a point of reference and reflection in two different contexts: upper secondary Biology education and non-formal adult education. The Biology education application focused on the development with teachers and students of a series of lessons during which the learner discovers, critiques and uses concepts of biodiversity. The non-formal adult education project focussed on making biodiversity meaningful to the general public of a small town in central Netherlands using people's back yards and balconies as a staring point. This project involved several NGO's (the butterfly society, and the local charter of the Dutch Society for Environmental Education), a community group, a university, a garden center and the local government. In both projects the products to be developed were, intentionally, unclear up front and needed to be determined and clarified by the participants in the interactive process.

Although the evaluation of the action research phase (research step 4) has not been completed yet, a few preliminary results can already be shared here. The stepping stone procedure for making biodiversity meaningful - *analyzing meanings of biodiversity, determining one or more perspective based on general learning goals for environmental education, setting concrete learning objectives, selecting specific (sub)themes for learning and valuing biodiversity* – is not used in any particular order. The step analyzing meanings of biodiversity is considered of particular importance in the formal education setting, while the step determining a specific perspective with which to approach biodiversity is considered crucial in the case developed in a non-formal education setting. One of the underlying goals of the procedure - *to help curriculum developers, teachers, educational support staff and environmental education consultants give specific meaning to biodiversity and to help learners critically analyze the way biodiversity is used in science-technology and society* – seems to be realized in the formal education setting. In the non-formal setting these learning goals are hardly met and seem to have less priority among the participants. Biodiversity here was mostly used to renew the attention for green space, nature in the city and the role of gardens as ecological entities and natural links with public green space. In both projects the procedure was not used as a blueprint or a recipe, but rather as guide and a reminder of alternative perspectives and possibilities.

The procedure shows that it is crucial to learn about different meanings, interpretations and uses of biodiversity and to be able to observe and monitor biodiversity and to critique its conceptual use in environmental and political discourse. Equally important, however, is the aspect of establishing the value of biodiversity. The normative character of biodiversity needs to be made explicit in the learning process for it to be called environmental education. To answer

the question of whether biodiversity loss is a bad thing, and if so, for whom, one must formulate a personal, well-argued position and reflect on one's own values. In raising such a question we will inevitably have to address the issue of equitable distribution and sustainable use, which are core components of both contemporary environmental education and the Convention on Biological Diversity. In the upper secondary education project these aspects have gained importance as a result of the stepping stone procedure, although it seems to be the case mostly in the higher level classes. In the non-formal setting, the attention to normative aspects was minimal and more attention was given to making local biodiversity a meaningful concept to the general public, but then mostly from an ecological perspective. The stepping stone procedure apparently was unable here, to bring in ethical and political perspectives on local biodiversity. Use of the stepping stone procedure does not guarantee that all aspects are given equal attention, even though the procedure does seem to heighten the participants' awareness of these aspects.

In addition to embedding biodiversity meaningfully in the personal world of the learner, the socio-scientific dispute character of biodiversity needs to be explored as well. Use of the stepping stone procedure seems to support the notion that the context determines whether this socio-scientific dispute character will be placed in the forefront or the background of the learning process. Viewed as such, learning about biodiversity is highly compatible with environmental education as a continuous learning process that enables participants to construct, critique, emancipate and transform their world in an existential way. *Construct* in the sense of building upon the prior knowledge, experiences and ideas of the learner. *Critique* in the sense of investigating underlying values, assumptions, world-views, morals, etc., as they are part of the world of the learner. *Emancipate* in the sense of detecting, exposing and, where possible, altering power distortions that impede communication and change. *Transform* in the sense of changing and shaping the world around them, regardless of scope or scale.

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